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Integration of farm components- the beauty of coconut homesteads

Soil Test Based Nutrient Management for Better Coconut Productivity

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Articles, research papers and letters on different aspects of coconut cultivation and industry are invited for publication in this Journal. All accepted material will be paid for. The Board does not accept responsibility for views expressed by contributors in this Journal. All remittances and correspondence should be addressed to the Chairman, Coconut Development Board, Kochi - 682 011.

Coconut Development Board

The Coconut Development Board is a statutory body established by the Government of India for the integrated development of coconut cultivation and industry in the country. The Board which came into existence on 12th January, 1981, functions under the administrative control of the Ministry of Agriculture and Farmers Welfare, Government of India, with its headquarters at Kochi in Kerala State and Regional Offices at Bangalore, Chennai, Guwahati and Patna. There are five State Centres situated in the states of Orissa, West Bengal, Maharashtra and Andhra Pradesh and in the Union Territory of Andaman & Nicobar Islands. DSP Farms are located at Neriyamangalam (Kerala), Vegiwada (Andhra Pradesh), Kondagaon (Chhattisgarh), Madehpura (Bihar), Abhayapuri (Assam), Pitapalli (Orissa), Mandya (Karnataka), Palghar (Maharashtra), Dhali (Tamil Nadu), South Hichachara (Tripura) and Fulia (West Bengal) besides a Market Development cum Information Centre at Delhi. The Board has set up a Technology Development Centre at Vazhakulam near Aluva in Kerala.

Functions

❒ Adopting measures for the development of coconut industry. ❒ Recommending measures for improving marketing of coconut and its products. ❒ Imparting technical advice to those engaged in coconut cultivation and industry. ❒ Providing financial and other assistance for expansion of area under coconut. ❒ Encouraging adoption of modern technologies for processing of coconut and its products. ❒ Adopting measures to get incentive prices for coconut and its products. ❒ Recommending measures for regulating imports and exports of coconut and its products. ❒ Fixing grades, specifications and standards for coconut and its products. ❒ Financing suitable schemes to increase the production of coconut and to improve the quality and yield of coconut.

❒ Assisting, encouraging, promoting and financing agricultural, technological, industrial or economic research on coconut and its products. ❒ Financing suitable schemes where coconut is grown on large scale so as to increase the production of coconut and to improve its quality and yield and for this purpose evolving schemes for award of prizes or grant of incentives to growers of coconut and the manufacturers of its products and for providing marketing facilities for coconut and its products. ❒ Collecting statistics on production, processing and marketing of coconut and its products and publishing them. ❒ Undertaking publicity activities and publishing books and periodicals on coconut and its products.

The development programmes implemented by the Board under the project Integrated Development of Coconut Industry in India are- production and distribution of planting material, expansion of area under coconut, integrated farming for productivity improvement, technology demonstration, market promotion and Information and Information Technology. Under the Technology Mission on Coconut, the programmes implemented by the Board are development, demonstration and adoption of technologies for management of insect pest and disease affected coconut gardens, development and adoption of technologies for processing and product diversification and market research and promotion.

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Message

Dear Readers,

The coconut sector in the country is joining hands with the coconut fraternity across the globe in celebrating the World Coconut Day on September 2nd, the foundation day of the International Coconut Community(ICC). This year the Board is celebrating World Coconut Day in Kochi with the participation of progressive coconut farmers from across the country, international delegates from ICC and the major coconut growing countries like Indonesia, Philippines, Malaysia, Thailand and Srilanka, winners of the National Awards and the Export Excellence Awards, scientists, researchers, officials from the different State Governments and entrepreneurs. The coconut community gathering at the World Coconut Day celebrations will be addressed by the Honorable Union Agriculture Minister Shri. Narendra Singh Tomar who will inaugurate the celebrations virtually and also declare the Awards instituted by the Board. The theme of the World Coconut Day Celebrations of 2022 is "Growing Coconut for a Better Future and Life". The presentation of the awards for the winners also be a boost to the coconut community in striving forward by growing more coconut and processing innovative coconut products leading to a better future and life for the farmers, entrepreneurs, consumers and all stakeholders linked to the coconut community.

The World Coconut Day celebrations will be followed by the International Workshop on Good Agricultural Practices (GAP) in Coconut, organized jointly by the Board and ICC during September 2-4, 2022. The workshop on GAP aptly follows the call for Growing Coconut, that too by practicing better agricultural management which will ultimately ensure the quality of the products. This is all the more significant at a time when the level of minerals, heavy metals and pesticide residues in food products is turning a mandatory requirement for quality assurance. The distinguished delegates from various coconut growing countries, representatives from the Food and Agriculture Organisation (FAO), Quality Council of India, GAP certifying agencies and progressive farmers will share their experiences regarding the various innovative and best practices adopted in coconut cultivation. A field visit is also arranged to coconut farms of progressive farmers in the country.

Sharing of experiences and adoption of best practices in coconut cultivation will help in developing a standard protocol of good agricultural practices that could be adopted in coconut for sustained agriculture. Coconut, being the Kalpavriksha, always allows for and takes care of all flora and fauna growing around it; let the quality of the coconut products also be made the best through best practices in cultivation.

Editor

Coconut based cropping systems with climate resilient tuber crops for enhancing farm income

A success story from Kollam district of Kerala

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Introduction

Coconut plays an important role in the agrarian economy of the four southern states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, which account for 90% of the coconut cultivation in India. There is ample scope for intercropping in coconut gardens with annuals and perennials utilizing the larger unutilized area (75%) between the trees due to the unique phyllotaxy and plant architecture. Tropical tuber crops such as cassava, elephant foot yam and greater yam are ethnic starchy vegetables with good production potential, cooking quality and taste, besides medicinal and nutritive values. Intercropping tuber crops in coconut gardens will enable food security, increase farmers' income and employment opportunities, leading to sustainable livelihood. The compatibility of tuber crops in coconut gardens have been experimented and documented. Among these, the suitability and profitability of cassava, yams (greater yam, lesser yam and white yam), elephant foot yam, tannia and arrowroot as intercrops in coconut gardens have been established and protocols for intercropping these crops have been standardized (Nayar and Suja, 2004). Coconut cultivation in the country is mainly done by small and marginal farmers with more than 90% of the coconut holdings with less than 0.40 ha size. The area, production and productivity of coconut in Kerala and India (CDB, 2020) are given in Table 1.

Table 1. Area, production and productivity of coconut in Kerala and India (2019-2020)

S.No.	District/ State/Country	Area ('000 ha)	Production (million nuts)	Productivity (nuts/ha)
1	Kollam	45.35	291.0	6417
2	Kerala	760.78	4814.0	6328
3	India	2173.28	20308.70	9345

Tropical tuber crops such as cassava, elephant foot yam and greater yam are important traditional foods in the diets of the people of Kerala. It is estimated that tuber crops provide about 6% of the dietary energy, apart from being good sources of β-carotene, antioxidants, dietary fibre and minerals. They have higher biological efficiency, can tolerate drought and shade, withstand flood and salinity to some extent, are adapted to marginal environments, low input situations and adverse soil and climatic conditions. Hence these crops are known as 'climate resilient' or 'future crops'. Experiments on cropping systems conducted over the years revealed that tuber crops were able to provide an average additional yield of 10-12 t/ha-1, additional profit of Rs. 1.0-1.25 lakhs/ha and employment generation of 150-200 man days/ha making the system economical and sustainable (Suja and Nedunchezhiyan, 2018). ICAR-Central Tuber Crops Research Institute has been pioneering systematically in the research and field experiments cum demonstrations on cropping systems for popularizing the technologies among farmers and other stakeholders.

Establishing demonstrations in farmers' gardens will encourage many others to follow cropping system for the improvement of their livelihood. Coconut is one of the major crops grown in Kollam district with an area, production and productivity of 45350 ha, 291 million nuts and 6417 nuts/ha, respectively (CDB, 2020). Keeping this in view, ten demonstration plots on coconut based cropping system involving tuber crops vis-à-vis soil health management' sponsored by Coconut Development Board, Ministry of Agriculture and Farmers' Welfare, Kochi were established in Kollam district for enhancing productivity and profitability of farming per unit area.

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Fig.1. Demonstrations on soil health management technologies in coconut + tuber crops system

SSNM technology in greater yam

Organic farming in greater yam

Organic farming in elephant foot yam

Implementation of on-farm demonstrations

Ten farmers who possessed coconut gardens of 50 cents area and who showed interest in taking up intercrops were selected with the support from officials of CDB and Krishi Bhavans based on the principles of participatory demonstration. Agro-techniques for tuber crops intercropped in coconut gardens were followed as per the recommendations of ICAR-CTCRI (Table 2). Planting materials of tuber crops were supplied and expenditures for planting and critical inputs were provided through funding from CDB, Kochi. Soil samples were collected prior to the beginning of the demonstrations for analyzing the nutrient status and chemical properties. Demonstrations were carried out based on the soil nutrient status and as per the standardized technologies.

Table 2. Agro-techniques for tuber crops intercropped in coconut gardens

Main crop	Intercrops/ Variety	Time of planting	Planting, spacing and population per ha	Duration (months)
Coconut (West Coast Tall)	Greater yam (Sree Keerthi)	June, 2019	Pit reformed to mound; 90x90cm; 9000 plants	8-9
	Elephant foot yam (Gajendra)	June, 2019	Mound; 90x90 cm; 9000 plants	8-9

Farmers' were trained on latest technologies with respect to coconut and tuber crops. Frequent farm advisory visits were carried out by the scientists to monitor the growth and yield performance of coconut and intercrops. The photos of demonstration plots are given in Fig. 1. The list of beneficiaries is given in Table 3.

Technological interventions

The technological specifications and treatments for on farm demonstrations of SSNM and organic farming technologies are given in Table 4.

Customized fertilizers based on SSNM: Technologies for SSNM in greater yam and elephant foot yam which could enhance the yield by more than 20% over farmers' practice, besides maintaining soil quality (Byju et al., 2016; Remya Remesh and Byju, 2020). Customized fertilizers consisting of macro and micronutrients based on soil test values were used for managing the nutrient requirements in tuber crops to attain specific yield goals.

Organic farming package: Organic farming technologies of tropical tuber crops at ICAR-CTCRI, indicated that organic farming resulted in 10-20% higher yield, 20-40% profit, besides improvement in tuber quality and soil health (Suja, 2013; Suja and Jaganathan, 2021). Organic production technologies developed for greater yam and elephant foot yam were used. Organic farming technology consisting of organically produced planting materials, organic manures, green manuring, bio-fertilizers and bio-control agents were used for managing the tuber crops organically.

Table 3. Details of demonstrations in greater yam and elephant foot yam in Kollam district

S.No.	Name & address of the coconut grower	Technology
1	Kamalamma G.R., Chelakkattu Veedu, Bharanikkavu, Chavara, Chavara Panchayat, Kollam	SSNM in greater yam
2	Sherly Yesudas P., Sherly Cottage, Puthukadu, Chavara, Chavara Panchayat, Kollam	SSNM in greater yam
3	Vijayan Pillai N., Vijayasree, Mukundapuram, Chavara, Chavara Panchayat, Kollam	SSNM in elephant foot yam
4	Rajan Pillai C., Kaleelil Veedu, Mukundapuram, Chavara, Chavara Panchayat, Kollam	SSNM in elephant foot yam
5	Rajankutty Pillai R., Mahalakshmi, Madappally, Chavara, Kollam	SSNM in elephant foot yam
6	Thomas John, Tinu Bhavan, Vadakumthala , Karunagappally, Panmana Panchayat, Kollam	Organic farming in greater yam
7	Noushad M., Poonjirikkal, Midappally, Edappallikotta P.O., Panmana Panchayat, Kollam	Organic farming in greater yam
8	Shafeeq K.K., Kezhakkedathu House, Puthanchantha P.O. Chavara, Panmana Panchayat, Kollam	Organic farming in elephant foot yam
9	Prabhakaran K., Thiruvonam Manayil, Panmana ,Panmana Panchayat, Kollam	Organic farming in elephant foot yam
10	Rajendran Nair K., M.S.H. Chenankara Junction Thevalakara, Panmana Panchayat, Kollam	Organic farming in elephant foot yam

Table 4. Technological specifications and treatments for on farm demonstrations

Treatments	Quantity of inputs per ha	
	Greater yam	Elephant foot yam
T1 (SSNM)	FYM @ 12.5 t ha-1, Customized fertilizers @ 740 kg ha-1	FYM @ 25 t ha-1, Customized fertilizers @ 740 kg ha-1
T1 (OF)	FYM @ 15 t, neem cake @ 1 t, Azospirillum @ 3 kg, phosphobacteria @ 3 kg and K solubilizer @ 3 kg, cowpea seeds sown in between greater yam (@ 20 kg) and green matter incorporated at 45-60 days @ 10-15 t, ash @ 1.5 t	FYM @ 36 t, corm treatment with Trichoderma @ 5 g per kg seed, neem cake @ 1 t, cowpea seeds sown in between elephant foot yam (@ 20 kg) and green matter incorporated at 45-60 days @ 20-25 t, ash @ 3.0 t
T2(POP)	FYM @ 12.5 t ha-1, NPK @ 80:60:80 kg ha-1	FYM @ 25 t ha-1 NPK @ 100:50:150 kg ha-1
T3(FP)	Farmer's practice	

SSNM- Site Specific Nutrient Management; OF-Organic farming; POP- Package of practices;FP-Farmer's practice

Layout and implementation: The layout and implementation of the demonstrations were done during June 2019 and February 2020 strictly under the guidance and supervision of scientists of ICAR-CTCRI and team members of the project. In those demonstrations designated for validating SSNM, the field was laid out into three, SSNM technology involving customized fertilizers (T1), present POP recommendation (T2) and Farmers practice (T3). Likewise, in demonstrations identified for validating organic farming, the field was laid out into three, Organic Farming technology (T1), present POP recommendation (T2) and Farmers practice (T3). This methodology was followed for greater yam and elephant foot yam. The critical inputs were weighed and applied as per the technical programme.

SSNM technology in elephant foot yam

Economics of cropping systems vis-a-vis soil health management in coconut + tuber crops systems

Two on-station proven sustainable nutrient management technologies viz., site specific nutrient management and organic farming technologies were separately demonstrated and validated (in comparison with POP and farmer's practice) in greater yam and elephant foot yam under intercropping in 10 coconut gardens of Kollam district and the findings are given below.

Pre-assessment of the coconut gardens before introducing the cropping system and sustainable nutrient management technologies were done in selected ten gardens of Kollam district and the results are given in Table 5. An average yield of 62 nuts per palm was obtained by the farmers during 2018-2019, which resulted in net income of Rs.1500 per year from one ha area with a B:C ratio of 1.01.

Fig. 2. Tuber yield of greater yam under different treatments of organic farming demonstration

Fig. 3. Corm yield of elephant foot yam under different treatments of SSNM demonstration

Table 5. Economics of coconut cultivation before the intervention (One ha)

Coconut (nuts palm-1)	Coconut yield (nuts ha-1)	Gross income (₹)	Gross cost (₹)	Net income (₹)	BC ratio
62	10850	108500	107000	1500	1.01

The results of the economics of coconut + tuber crops cropping system vis-a vis soil health management viz., SSNM and organic farming technologies are given in Table 6.

The coconut + greater yam cropping system experiment on SSNM technology conducted in Kollam district during 2019-2020 revealed that (Table 6) the highest tuber yield was obtained under SSNM (9.73 t ha-1), followed by POP (8.01 t ha-1) and farmer's practice (6.39 t ha-1) (Table 6). Similar trend was observed with regard to yield of coconut. The net income of Rs. 2.43 lakhs per ha was obtained in SSNM plot, followed by POP (Rs. 1.78 lakhs) and farmer's practice (Rs. 1.16 lakhs). Benefit: cost ratio was highest in SSNM (2.10), followed by POP (1.83) and farmer's practice (1.54).

In the case of organic farming technology demonstrated in coconut + greater yam cropping system, the highest yield was obtained from organic farming (4.59 t ha-1), followed by POP (3.99 t ha-1) and farmer's practice (3.96 t ha-1) (Table 6 & Fig.2). The coconut yield was higher under organic farming, followed by POP and farmer's practice. The net income of Rs. 82900 per ha was obtained under organic farming, followed by POP (Rs. 39400) and farmer's practice (Rs. 32850). The benefit: cost ratio from organic farming was higher (1.43), followed by POP (1.18) and farmer's practice (1.15).

Table 6. Economics of coconut + tuber crops cropping system vis-a-vis soil health management

Technology	Coconut yield (Nuts/ha)	Tuber yield (t/ha)	Gross Income (₹)	Gross Cost (₹)	Net Income (₹)	BC Ratio
Economics of coconut + greater yam cropping system: SSNM Vs POP Vs FP						
SSNM	12250	9.73	463050	220000	243050	2.10
POP	11200	8.01	392350	214000	178350	1.83
FP	10850	6.39	332150	216000	116150	1.54
Economics of coconut + greater yam cropping system: OF Vs POP Vs FP						
OF	11725	4.59	277900	195000	82900	1.43
POP	11375	3.99	253400	214000	39400	1.18
FP	11025	3.96	248850	216000	32850	1.15
Economics of coconut + elephant foot yam cropping system: SSNM Vs POP Vs FP						
SSNM	13300	8.28	464200	355000	109200	1.31
POP	12950	7.72	438300	375000	63300	1.17
FP	12775	5.44	345350	345000	350	1.00
Economics of coconut + elephant foot yam cropping system: OF Vs POP Vs FP						
OF	12250	11.40	578500	370000	208500	1.56
POP	12600	9.78	517200	375000	142200	1.38
FP	12425	7.98	443450	360000	83450	1.23

Fig. 4. Corm yield of elephant foot yam under different treatments of organic farming demonstration

The SSNM technology validated in coconut + elephant foot yam cropping system during 2019-2020 revealed that (Table 6 & Fig.3) the highest corm yield was obtained from SSNM plot (8.28 t/ha), followed by POP (7.72 t/ha) and farmer's practice (5.44 t/ha). Similar trend was observed in the case of coconut yield. The net income of Rs. 1.09 lakhs per ha was obtained in SSNM plot followed by POP (Rs. 63300) and farmer's practice (Rs. 350). Similar trend was observed with regard to benefit: cost ratio viz., SSNM (1.31), POP (1.17) and farmer's practice (1.00).

The organic farming technology demonstrated in coconut + elephant foot yam cropping system during 2019-2020 revealed that (Table 6 & Fig.4) highest corm yield was obtained under organic farming (11.4 t/ha), followed by POP (9.78 t/ha) and farmer's practice (7.98 t/ha). Whereas, the coconut yield was maximum in POP plot, followed by farmer's practice and organic farming. The net income of Rs. 2.08 lakhs per ha was obtained under organic farming followed by POP (Rs. 1.42 lakhs) and farmer's practice (Rs. 83450). Similar trend was observed with regard to benefit: cost ratio viz., organic farming (1.56), POP (1.38) and farmer's practice (1.23).

Conclusion

On-farm demonstrations on SSNM using customized fertilizers and organic farming technologies in tuber crops have proved that coconut + tuber crop system performed better with respect to yield, cost benefit analysis, soil health improvement and overall system productivity in all the ten gardens of Kollam district of Kerala. The validated technologies are given to KVKs, Department of Agriculture and other line departments for popularization and scaling up of the technologies in larger areas for doubling farmers' income on a sustainable basis. These demonstrations will serve as model plots for other farmers to adopt improved technologies in coconut farming, which warrant the efforts from all stakeholders viz., ICAR-CTCRI, CDB, Kochi, Department of Agriculture, Krishi Vigyan Kendra, farmers, input agencies, marketing traders etc.

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Integration of farm components- the beauty of coconut homesteads

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Coconut based homesteads are farmer-based agroforestry systems for meeting local food and livelihood needs in an ecological system approach. ICRAF (1993) defined agroforestry systems wherein perennial trees/palms/crops are cultivated or grown based on spatial or temporal arrangements where ecological and economical interaction benefits the production and carbon storage. Majority of coconut farmers have small and marginal land holdings, being cultivated in contiguous manner. In Alappuzha district,Kerala good number of the households had one or more backyard ponds which are not only water collection and storage mechanism, but also utilized for natural fish culture and used for household activities. Small holders farming are very much heterogeneous in terms of resources like land, soil fertility, cropping systems, mixed farming, off farm income, social personal traits and such multiple dimensions. Hence arriving to a general module of integrated farming system or coconut based homestead system is rather impossible, since the objectives, modus operandi and the socio personal dimensions warrants customized integration and incentivization. Some of the basic incentivization obtainable through integration in homestead systems is delineated in the ensuing portion.

Aquaponics unit combining crops and water purification


Azolla and fish in artificial pond


Caring poultry satisfies both farmer and birds


Coconut Intercrops

Effective resource utilization

Optimum production of quality and safe fish which is a taste favorite and cheap quality protein source for the state population in general,needs further impetus through intensification of scientific pond fish culture besides marine and freshwater fisheries. Pond fish culture in coconut based homestead system and vegetable in pond banks provide multiple farm products with less cost from small area.Integration of viable traditional knowledge and skills can upgrade mutual benefits from these components. Homestead ponds also act as natural mini reservoirs for collection and storage of rain water, irrigation for crops, drinking water and bathing requirements of animals as well as a natural water based ecosystem unit favoring ecological services. Natural resource management, in the present scenario of climate change assumes importance at macro and micro levels. Homestead system with multiple components like main crops, intercrops, fish culture, livestock, poultry and combination of wood trees and wild weeds catering to the service of the pollinators of the system as well, could be seen as farmer evolved models.

Cost reduction

Adequate and proper investment in farming is of a major concern for the majority of resource poor farmers. In coconut based homestead systems, there is a mutual reuse and recycling of farm products for the households, livestock and the organic waste recycle for fish culture and manure preparation,thus reducing 40 to 60 per cent of the recurring cost and enable inching towards low external input system. Homestead systems are usually one of the best models of family farming among small and marginal farmers of developing and under developed countries. Even though they are not considered as a high income generating units, they are catering majority of the rural and urban families with fresh farm produces having source credibility. The involvement of the family members, contribute not only for the cost reduction but also provides better opportunities for effective time management in farming and social needs as well as in experiential skill development mode through active participation in farming.

Balancing environment and diet needs

Like a balanced diet plate, homestead unit partitioning of the farming space to be planned and managed for balanced resource efficient production of fish, meat, egg, milk, vegetables, oils, fats, fruits,

Fodder as intercrop

Healthy poultry are happy birds

Indbro bown

Natural pond revived for fish farming in coconut homesteads

spices, carbohydrates and the like in a viable mode. Ecological units of farming are thus evolved over long periods of temporal and spatial level of sustainable choices and combinations. These systems ensure balanced diet having diet diversity from minimal food mile to maximum livelihood security. The environment and nutrition are not only the basic needs of human beings, but also for livestock, poultry, fish etc.as well as the natural fauna and flora components having indirect and direct effect on farming. Hence the idea of balancing components needs the consideration of the nature's balance embracing the principle of macro level inclusiveness.

Sustainable income with low risk

Building of coconut based systems results in natural services, increased production and income from unit area offering low cost efficient choices of reusing, recycling and reducing the use of external inputs. Risk cushioning is ensured in integrated farming systems, but experiences from participatory research indicated for the need of minimum of 0.25 to 0.4 ha or clustering of land holdings under group farming

Coconut homesteads – farming for the home

Homesteads in Malayalam language is "Purayidakrishi" meaning farming in the areas surrounding the house for farm produces to meet the multiple needs of the family members and marketable surplus in an efficient, environmentally sustainable and integrating way for household members. In the scenario of higher population pressure and shortage of cultivable land, the intensification of homesteads is imperative for the nutritional security of farm families. Home gardens around the world had the basic features of multistoried cropping systems and integration of other components including domestic and pet birds/animals with courtyard gardens. These type of systems are known with varied acronyms such as home gardens, agro forestry home gardens, household farms, backyard gardens, compound farms, village forest gardens, mixed gardens etc,. These type of systems warrants promotion through participatory schemes or projects with policy back up, as independent operational farming units, conferring environmental and social benefits besides economical and health benefits. Conservation of biodiversity, natural resources, food in the vicinity ensuring the source and production procedures, enabling ecosystem services, nutrient recycling with reduced soil erosion, are direct and indirect benefits accrued.

In Kerala as in any other parts of the world, these home gardens remain relevant and critical to the local food and economical security through its functional and structural diversity. The structural diversity is reflected in the multispecies, multistoried cropping system with perennial tree species in the upper layer, tubers, banana etc,.in the second layer and annual spices, vegetables etc,. in the third ground level with maximum resource use efficiency in harnessing solar energy, nutrition, moisture and water. The functional diversity includes meeting needs of food, fuel,timber and organic residues and medicines. Livestock and poultry rearing with sufficient space for natural flora and fauna reflects the wisdom and insight of the foresightful farmers of yester years. We can observe that subsistence level traditional farming styles and commercial homestead gardens are practiced by farmers.

Livestock and poultry rearing with sufficient space for natural flora and fauna reflects the wisdom and insight of the foresightful farmers of yester years. We can observe that subsistence level traditional farming styles and commercial homestead gardens are practiced by farmers.

Reducing wastage and pooling homestead resources

An attitude change is needed for proper use of seasonal and traditional fruit crops in coconut gardens through grading, marketing and processing for long term storage and usage, which is being wasted at present. The crop combinations itself is a proof of bio diversity preservation at village level. Research and extension programs may reorient and redefined to evolve efficient individual and social models of integrating technological interventions of research-based recommendations at system basis, mechanisms for pooling farm produces, setting up rural marts for marketing them as fresh and green products as well as processing units for activating value chains. But several studies showed that market led consumption determines the pattern of production behavior in homesteads. When the households are not depending farming for livelihood, they tend to buy from markets rather than cultivating on their own. Commercialization of cropping with shift from coconut to rubber, paddy cultivation land conversion for non-agricultural purposes etc are the case of shifting of households from farming to commercial ventures, eroding the very essence of home gardening citing low marketable surpluses, very high labor charges and scarcity in getting skilled laborer. Usually, households do not consider the savings in income reducing the consumption expenditure compared to market value and also the indirect savings in medical expenses through consuming safe food.

Conscious Consumption – Green dream

Consumption of fresh food with zero food mile are energy saving and sustainable moving away from utmost consumerism replacing consumers with producers.

The agricultural production in homesteads, immediately around the home, observed /nurtured by the farm family and use of food produced as well as collected or foraged from the nearby areas leads to nutrient self-sufficiency, to a certain extent. Some of the key actions are resorting to technologies or methods for converting organic wastes from farming and kitchen, as manures. The recycling and reuse in homesteads involve livestock, fishes as well as birds, insects and small animals in the ecosystem. Cultivating culture and habits of this sort needs individual attitude change, conscious energy consumption along with social empowerment, participatory natural resource conservation and roles in shaping policies at local and macro levels.

Reskilling community members in agriculture and consumer transition habit changes the consumerism towards positive behavior. The home gardening system, teaches us the importance of nature friendly harvesting of water, solar energy, nutrients and natural factors to transform them as food, medicines, flora and fauna systems. Designing the land space which is a continuous learning and relearning process is the basis of developing an ecosystem based homestead farming management. A green dream of conscious consumption can be made a reality through technology based integration of component resources, finding niches of resilience, addressing climate change through continuous observation and analysis based experimentation.

Integration and incentivization – Case of homestead remodeling

Sri Sivaprasad is an educated rural youth who is determined to reinventing his destiny through farming based on integration of coconuts, inter/ mixed crops, livestock, poultry and fish culture. The incentivization is through recycling organic wastes

as manure, conversion of food and fish wastes to high content low cost protein through using black soldier flies, fuel and digested organic manure from biogas unit and production of layer birds chicks of indigenous breeds for larger adoption among farmers. Other incentives being derived is upgraded social acceptance, reinventing his role as a master trainer, strengthening linkages with research and extension agencies, active role in farmer producer organizations, effective time management, providing responsible farm products for conscious customers and obtaining awards and accolades for his innovative farming ventures.

Intensive fish culture through Bio Floc method- potential and problems

The young farmer Sri Sivaprasad who is an active participant and partner of ICAR CPCRI Farmer FIRST program (FFP), resides in Ward 16 of Pathiyoor panchayath, Alappuzha district, Kerala (FFP implementation location) own 0.75 acres of land holding where he is practicing coconut based homestead system.The dream choice after his tenure in gulf region was embracing and intensifying the integrated farming system in his inherited land from his father who was a very successful farmer also. The challenge was to decide on logical and feasible investment to derive decent income from farming choices. The first move he made was to invest in bio floc system of intensive fish culture investing more than 20 lakh for the units. Thorough training he obtained and the venture rolled on with confidence. But the realization that the break even point could be reached only over time period and the challenges in marketing fresh water quality fish competing with the traditional consumer choice of marine fishes at low cost was really challenging and a painful learning. Recurring cost of bio floc in terms of uninterrupted daily electricity consumption,difficulty in getting reliable quality fingerlings in adequate quantity and difficulty in marketing led him to adopt technologies and social innovations for thriving them. Unlearning and relearning the techniques of bio floc culture, utilizing solar energy, trying locally preferred fishes and linking with fish fingerling producers were some of the adaptive measures tried by this young farmer. The fish culture unit was named as ' MURNI Hi tech Fish Farm' meaning pure in Malay language which was started for providing safe, fresh and quality fishes organically cultured and free of any chemicals to the consumers.

FFP interventions with farmer participation

The interventions of Farmer FIRST Program was the rejuvenation of coconut palms in the homestead with integrated root (wilt) disease management practices and the yield could be improved by 48 percent over three years. Other components were the introduction of desi cow and demonstration of HYV of fodder such as CO 5 of TNAU and Susthira from KAU. Both the varieties are well preferred by the animals and amenable to multiple cuts. The organic wastes from the cowshed is being recycled for the growth of the fodder. Intensification of intercrops with ICAR IISR Pragati turmeric, tubers such as amorphophallus, colocasia and tapioca, vegetables (amaranthus, snake gourd, local leafy vegetables etc), sesamum (TMV 4 (TNAU) for family needs and market surplus also. The pest problems, button shedding posing constraints in timely adoption of management practices due to changing climate situations according to him. The pressing demand is to evolve resilient strategies to overcome climate change impact in crop loss and perpetuating new problems through farmer participatory and field oriented research actions. The quality conscious customers and the improved standard of living of society demands for more protein rich diet such as meat, egg and milk produced organically and naturally. ICAR CPCRI FFP interventions of introduction of indigenous and improved breeds like Giriraja, Indbro Brown, Kadaknath, Kairali, Aseel, Gramapriya and Gramajyothi. The demand and market of eggs are very encouraging and additional income ensured through production of quality layer chicks of these breeds using semi automatic egg incubator. This will enable the rural women and farmers with sub marginal land holding size also to grow poultry birds either in cages or in terrace cages designed without hampering roof strength as adopted by several farmers of the FFP panchayath. The preference for eggs of indigenous breed is to be utilized through ensuring production factors and source credibility as in his homestead unit.

The egg weight of the birds in the initial period was improved over time and the eggs are fetching premium price due to the ensured quality.

Technologies for reducing cost and being organic

The reuse and recycling ofcowdung and urine of desi cow reduced manure cost for fodder, coconuts and intercrops. Cow urine based natural pesticides

Sivaprasad in biofloc fish unit

are being used in vegetables for organic farming in his homestead. The organic wastes obtained from Bio floc unit is being recycled for basin management of coconut palms and found to be improving the yield of vegetables considerably. The field experiments are in progress regarding the use of bio floc fish wastes. The fish wastes with blood content after primary cleaning and cutting while marketing posed problems of insects, rats and foul smell of decaying. The problem was solved by adopting biogas unit for production of gas for kitchen purpose thus reducing cost of cooking gas and bio slurry as manure for crops.

Cost of fish and poultry breed is a real concern of farmers due to its very high cost and the regular increase in the price. Balancing market price of farm produce with the escalating price of critical inputs force farmers either towards low level of management or discontinue the units. FFP could intervene and introduced azolla growing in artificial pond which could be used as a very quality feed for livestock, poultry and also fishes. Utilizing black soldier flies (BSF) is trendy among farmers who are management conscious, both the farm components as well as organic wastes conversion. Under FFP we tried the low cost unit of BSF among 20 farmers and Shri Sivaprasad is one of them. The food wastes, fish and vegetable wastes can be converted to high quality protein feed as larvae of BSF using this simple technique. The result of these components are visible in the very agile, active and healthy stand of the poultry birds in his farm. Hence planning and incorporating appropriate technologies which are simple and purposive leads to viable management options according to this enterprising farmer.

Fish farm school- an innovation in homestead

A farm school is a practical learning location for experiential learning through self teaching as well from an expert farmer in the very raw fields of adoption for any farming techniques. Learning by observation, being with the techniques and practicing them develop the finer skills and practical tacit knowledge. The fish farm school set up in FFP of ICAR CPCRI in his homestead consisted of biofloc fish culture by the farmer himself, artificial pond with fish and azolla growing, natural pond with fish culture suitable for that ecosystem integrated with vegetable cultivation in banks and small aquaponics unit demonstrating the potential of fish cum natural cleansing of recycled water utilizing plants. Commercial viability of homesteads could thus be improved incorporating additional components and refining techniques based on the experience and practical wisdom of the farmers.

Small is beautiful and offers to be productive

Integration of farm components are not only the choices of the farmers but meeting the needs of the family and the society with responsibility. Small and marginal land holdings could be well planned and designed to be more productive, diverse, organic and commercial to a certain extend. The total pooled production of farm components in these homesteads are potential future towards food sovereignty ensuring safe and balanced diet for the future. The imperatives of the present time demands everyone to be farmers or meet at least a portion through their own farming, whether through homesteads as in rural areas, terrace gardening in urban and urban farming points for social agriculture can lead to environmental services also. The agricultural research needs reorientation towards technology packages with varieties/breeds, small machinery, less labour intensive, low external input social farming innovations. Attracting the younger generations towards farming as a choice of hobby and spiritual experience and natural indulgence of green habits needs attention of policy makers.

The homesteads are models and innovations evolved through generations offering resilience and hope for solving several present day farming woes in general. It offers customization, rural and urban choices of combinations, spatial and temporal dimensions and as ecological units of environmental salvation. The science, philosophy and spirituality of homesteads providing and sharing spaces and basic needs of the farm family , society and the nature also is of utmost importance and of high level of responsible satisfaction. ■

Re-emergence of lethal wilt disease in east coast regions of Tamil Nadu

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Coconut (*Cocos nucifera Linn.*) is one of the versatile plantation crops that provides livelihood security to more than 12 million farm families worldwide. Coconut has been extensively cultivated in the east coast regions of Tamil Nadu and forms the backbone of agrarian economy in this tract. The coconut farmers faced a severe setback due to the Gaja cyclone in 2018 that ravaged the coconut plantations in this region. Farmers are slowly limping back to normalcy with planting of new coconut seedlings. Amidst such a situation of crop loss and recovery thereafter, the re-occurrence of the lethal wilt disease of coconut in Thanjavur district was reported during February - March 2022. This disease was first reported from this region during 2007 as a disease of unknown etiology and later named as lethal wilt disease (LWD) in 2021 after characterizing the phytoplasmal pathogen associated with it. Being a region endemic to basal stem rot disease (Thanjavur wilt), farmers are hereby sensitized about the re-emergence of LWD and symptoms of these two diseases for better clarity, understanding and for further timely follow-up.

Lethal wilt disease (LWD)

As the name indicates, this is a lethal disease that kills the palm. This disease is associated with phytoplasma belonging to '*Candidatus* phytoplasma asteris'(16SrI-B), a prokaryotic phytopathogenic bacteria. Phytoplasmas are usually restricted to phloem of palms arresting the translocation of photosynthates. Abnormal and sudden nut fall including buttons is the first characteristic symptom of LWD. Inflorescence necrosis and shedding of male flowers will be immediately followed. Yellowing and bronzing of leaves progresses from the outer whorls to spear leaf. The dried leaves remain hanging on the crown (skirting of leaves around the trunk) for a few days before detachment from trunk. As disease advances, necrosis and rotting of spear leaves and death of growing point occurs (Fig.1). Eventually, the entire crown perishes leaving a bare trunk. Affected palms die within 3-5 months after the appearance of the initial nut fall symptom. The rapid death of palms is definitely a matter of concern to the farmers of the region.

Occurrence of LWD affected palms is seen in leaps and jumps typical to vector transmission. Phytoplasma disease is usually transmitted by auchenorhynchan hemipteran insects which has not been established in the case of LWD so far. LWD is normally noticed during December to June, with a peak during summer phase (February - May). This may be due to the active prevalence of the vectors

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during summer months.The transmission rate is quite slow in the region.

Re-emergence of LWD

After the first report during 2007, the disease incidence was gradually progressing in east coast of Tamil Nadu. During 2016-2018, LWD was rampant in Thanjavur, Thiruvarur and Pudukottai districts of Tamil Nadu killing more than 300 palms. In November 2018, Gaja cyclone has devastated coconut plantations in the LWD endemic tracts. As majority of the adult yielding palms were uprooted and destroyed by the cyclone, there was no report on the occurrence of LWD in the three subsequent years. But during February -March, 2022. farmers and agricultural department officials from Enathi and Seruvaviduthi villages (Pattukottai Taluk) in Thanjavur district reported the occurrence of palms showing typical symptoms of LWD. The inflorescence and spear leaf samples collected from a symptomatic palm in Seruvaviduthi tested positive for LWD phytoplasma in polymerase chain reaction test using phytoplasma specific primers. Based on the nucleotide sequences of 16S rRNA region and virtual RFLP the association of LWD phytoplasma Candidatus phytoplasmaasteris was identified, confirming the re-emergence of the LWD in east coast of Tamil Nadu after Gaja cyclone

Management

- Periodic surveillance in plantations in disease endemic tracts
- Immediate uprooting and destruction of palms after diagnosis of typical symptoms.
- Regular removal of weeds in the system to avoid harbouring of pathogens.
- In order to de-risk farmers compatible intercrops are advised in the coconut plantations for steady and continuous income.

Basal stem rot (BSR) disease (Thanjavur wilt)

This is a fungal disease caused by the soil-borne *Ganoderma spp.*. Being a debilitating disease, it affects the palm health significantly.In India, severe incidence of the disease was first reported from Thanjavur District of Tamil Nadu during 1950s and hence the disease is commonly known as Thanjavur wilt. The infection starts from roots and symptoms are seen in the crown as yellowing and wilting of leaflets during the initial stages, often confused with the symptoms of severe drought. The dried fronds of the lower whorls droop down from their point of attachment and hang vertically downwards to form a skirt around the trunk apex. The drooped leaves fall off one by one leaving only a few leaves at the apex. As the disease progresses normal development of flowers and bunches is arrested. Nut yield is considerably reduced over a period of time.In course of time, the apex of the trunk shows tapering with the advancement of the disease, and bleeding symptoms may appear on the bole region. Initially these bleeding patches appear on several places as parallel vertical streaks. They soon coalesce, forming a discoloured band around the trunk(Fig 2). These brownish patches may extend up to l m from ground level. Emergence of fungal brackets are observed in certain cases, mostly after the death of the palm. In severe cases, the crown is easily blown off by wind, leaving only the decapitated stem.Occasionally, some infected palms do not show bleeding patches.

Management

Basal stem rot disease is found contiguous and in patches in a locality. Such palms sustain for a long period of time if adequate management options are undertaken. integrated disease management practices involving following components are recommended

- Removal of dead palms and palms in advanced stage of the disease and destruction of the boles and root bits of the diseased palms
- Isolation of neighbouring healthy palms, by digging isolation trenches around the affected palm
- Application of *Trichoderma* enriched neem cake (5 kg per palm at six monthly interval)
- Intercropping with banana
- Treat severely infected palms by root feeding of hexaconazole @ 2%(100 ml solution per palm) and soil drenching with 0.1 % hexaconazole or with 40 l of 1 % Bordeaux mixture in the coconut basin .
- Application of neem cake (5 kg) fortified with *Trichoderma harzianum* (CPTD 28)talc formulation (50 g)per palm per year at six monthly intervals help in reduction in the incidence and recovery of the affected palm.
- Avoid flood irrigation.Excessive irrigation and submergence of palm basin with water aggravates the disease spread
- Soil-test based palm nutrient application for regaining the heath of the palms

How to differentiate between BSR and LWD symptoms ?

Both LWD and BSR are present in the Thanjavur, Tiruvarur and Pudukottai districts of Tamil Nadu and have some of the symptoms like foliar yellowing, skirting of dried leaves around the trunk etc in common. This may cause confusion among farmers in the identification of the disease. Based on the distinct and characteristic symptoms, the disease can be diagnosed appropriately and proper management is to be undertaken at the earliest.

Basal Stem Rot	Lethal Wilt Disease
Nut yield reduced	Abnormal nut fall and shedding of buttons
Yellowing , drying and drooping of older leaves that progresses very slowly	Bronzing and yellowing of older leaves and proceeds to spear leaf within 2-3 weeks
Bleeding patches on the base of the trunk	Bleeding patches absent
Slow weakening of palms	Rapid death of palms in 3-4 months
Disease incidence in patches	Disease incidence in random

In the case of LWD , surveillance for identification of diseased palms and timely uprooting / destruction of affected palms are very crucial to arrest the spread of the disease. Farmers need not panic but correct understanding of symptoms and adoption of recommended management practices are effective for successful management of BSR. Evolving emergency preparedness module to tackle LWD is the need of the hour. Strengthening quarantine and timely diagnosis are very important to halt biosecurity threats looming into the country. ■

Soil Test Based Nutrient Management for Better Coconut Productivity

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Coconut, the tree of life or the'Kalpa Vriksha' occupies a predominant position in our daily life more particularly that of the South Indians. The proximity of our geographical area to the Arabian Sea might be one of the reasons for this much trivial role of coconut in our routine. However a gradual decline in coconut productivity is noticed over the years. Several reasons are attributed to this decline such as the unscientific management practices, pests and diseases along with price fluctuation and shortage of manpower for various cultural operations. Along with these reasons, the declining soil productivity also contribute towards the ill health of coconut palms. The soil health factors need to be considered for developing a scientific nutrient management plan for coconut. In this paper, the soil test based nutrient management options for sustaining coconut productivity is elaborated.

The soil test based nutrient management is a sequential process involving the following steps: Site selection, soil sampling, processing of soil samples, analysis in the laboratory, categorisation of the analytical results, developing soil test based nutrient recommendation and ultimately developing a soil test based nutrient management plan.

1. Site selection

In a coconut garden, palms are planted at a spacing of 7.6m X7.6m. Basins of the palms are taken around it at a radius of 2m. The soil samples are to be taken at a distance of 1 meter from the trunk of the palm from three distinct positions forming a Benz shape. The samples are to be taken at a depth of 30-45 cm from the surface. A 'V' shaped cut is taken and the samples are drawn on either sides of the 'V'. The samples drawn from the three points are composited and finally 200-300g samples are taken, which is to be dried in the shade later it is packed in plastic containers with proper labelling.

In case, if the farmer wants to assess the general fertility status of a coconut garden of 1 acre, sampling should be done in between four different coconut palms. Samples collected in this manner from four or five different points are composited, quartered to get a final representative sample.

In the laboratory, these samples will be sieved through sieves of specified mesh sizes and are processed for the estimation of various soil health parameters such as soil pH, electrical conductivity, organic carbon, available phosphorus, potassium, calcium, magnesium, micronutrients such as iron, manganese, copper, zinc and boron.

Based on the values of each parameter, recommendations will be developed for the soil sample analysed.

Correcting soil reaction

Soil reaction is represented as soil pH. If the pH is in the acidic range, liming should be done. Dolomite @ 1 kg per palm two weeks prior to the application of fertilisers is the recommended strategy for combating soil acidity.

The blanket fertiliser recommendation for coconut is 500g N: 320g P:1200g K. The nutrients shall be given in two splits under rainfed condition. However, depending on the stage of growth the amount of nutrients to be added varies. For the juvenile palms it can be applied 3 months after planting and $1/10^{th}$ of the recommended dose shall be given.

After one year of planting, $1/3^{rd}$ of the recommended dose shall be given. At the stage of two year after planting, $2/3^{rd}$ of the total recommended dose have to be given. After the third year, full dose as recommended can be given.

Under rainfed conditions, fertilisers can be applied in two splits: $1/3^{rd}$ to be given with the receipt of South West monsoon during June and the remaining

2/3rd dose shall be given during September-October. Under irrigated conditions, these fertilisers can be given in four equal splits at three months interval.

Boron deficiency is rampant in coconut growing tracts. The symptoms are manifested as fasciation (failure of leaflets to split open), inflorescence necrosis, button shedding. Such palms should be given borax @ 40g per palm in 4 splits, along with compost or dried farmyard manure @ 25kg/palm.

In order to combat the deficiency of magnesium, which is manifested as foliar yellowing, it is recommended to apply 500g magnesium sulphate per palm along with the second split application of fertiliser during September-October.

The following table depicts the dose of fertilisers to be given at each stage.

Table 1. Nutrient recommendation for coconut

Stage of the palm	Organic manure	Urea	Musso-riephos	Muriate of potash
	kg/palm	g/palm /year		
Kerala				
3 months after planting	5	100	150	200
1 year after planting	5	360	500	668
2 year after planting	10	720	100	1300
3 year after planting onwards	25	1000	1500	2000
Tamil Nadu				
6 months after planting	10	-	-	-
1 year after planting	20	304	400	500
2 year after planting	30	608	800	1000
3 year after planting	40	911	1200	1500
4 year after planting	50	1215	1600	2000
Karnataka				
3 months after planting	20	109	200	225
1 year after planting	20	347	600	676
2 year after planting	20	716	1200	1350
3 year after planting onwards	50	1085	1600	2000

(Source: 1. Coconut Cultivation Practices. 2007.ICAR- Central Plantation Crops Research Institute, Kasaragod, Kerala. Eds. (Dhanapal, R., Thampan, C).Extension Publication No. 179.p.26.

2.http://www.agritech.tnau.ac.in/expert_system/coconut/coconut/coconut_mainfield.html)

3.Package of Practices Recommendations, University of Agricultural Sciences, Bangalore

Enriching soil fertility with leguminous crops

Because of the innate ability of the leguminous crops to tap atmospheric nitrogen in the root nodules, they can serve as live nitrogen suppliers to the plant. Sowing 100g cowpea seeds along with first dose of fertiliser and when one or two plants have started flowering, by 45th to 60th day of planting, they can be turned in to the field. This practice can

Fig. 1. Boron deficiency symptoms in coconut

provide 25-30kg biomass per basin along with 150g nitrogen can be supplied. This can enrich soil fertility. This sort of basin management with leguminous crops can also promote microbial activity favouring the nutrient mineralisation and its release for palm growth. Apart from cowpea, sun hemp, horse gram, mimosa and daincha can also be sown in the basin.

Nutrient mixtures for juvenile palms and adult palms

Considering the soil nutrient status and the palm nutrient requirement, ICAR-Central Plantation Crop Research Institute, Regional Station, Kayamkulam has developed two nutrient mixtures viz., 'Kalpa Poshak' and 'Kalpa Vardhini' for juvenile and adult coconut palms, respectively. 'Kalpa Poshak' comprises of the nutrients such as potassium, boron, sulphur, zinc copper whereas 'Kalpa Vardhini' contains potassium, magnesium, sulphur, boron and zinc in different concentrations. The dose recommended for 'Kalpa Poshak' is 40 g/ palm during first year after planting and 100 g/ palm in two splits @ 50g per dose for the second and third years of planting. The dose for 'Kalpa Vardhini' is 500g/palm/year in two splits @ 250g/dose. These mixtures are to be added 10 days after the normal dose of fertilizer application as per the schedule.

Irrigation

One of the critical resources in coconut production is the availability of water. Water is the medium for absorption of plant nutrients. For all physiological process within the plant including photosynthesis, water is essential. There is constant upward movement of water from soil solution through the roots of palms under transpiration pull. Sufficient water should be available in the root zone to maintain plant functions and productivity. Though the coconut growing regions in the coastal belt are endowed with high rainfall, the rainy period is confined to few months during the monsoon season. The palm experiences moisture stress and drought conditions for varying periods extending up to 5-6 months in a year which affects productivity. In the coconut growing region other than the coastal belt coconut has to be grown throughout the year by supplemental irrigation. When irrigation water is delivered through hose pipes, about 250 litres water is required to be applied every 4 days per palm. But when drip irrigation is followed, irrigation is scheduled to compensate the loss of water through evapo transpiration which amounts to 32-40 litres per day for adult palms, under Kerala conditions.

Conclusion

Considering the peculiarity of coconut as a perennial tree crop, systematic and scientific nutrient management will enable it to attain the potential yield. However, owing to the continuous removal of nutrients from the soil, soil testing in a coconut grove should be resorted at least once in two years. Application of the right quantity of nutrient at the right time will enable the palm to make more efficient utilization of the applied nutrient which can enhance the fertiliser use efficiency, thereby reducing the cost of cultivation. Irrigation, liming, organic manure application and soil test based nutrient application should form the components of the systematic soil health management practice for coconut. ■

Strengthening Quarantine and Incursion Management of Invasive Pests on Coconut

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Abstract

Invasive pests upset biodiversity and threaten human livelihood worldwide. International trade facilitates their arrival and environmental modulations especially climate change induced biome shift encourage their rapid establishment with ease. Here, we outline the invasive pests on coconut viz., coconut eriophyid mite (*Aceria guerreronis Keifer Acarina: Eriophyidae*), Asian grey weevil (*Myllocerus undatus Marshall Coleoptera: Curculionidae*), inflorescence caterpillar (*Batrachedra arenosella Walker Lepidoptera: Batracheridae*), whiteflies and nesting whiteflies (*Aleurodicus dispersus Russell, Aleurodicus rugioperculatus Martin, Paraleyrodes bondari Peracchi, Paraleyrodes minei Iaccarino and Aleurotrachelus atratus Hempel Hemiptera: Aleyrodidae*) and the potential economic damage inflicted on coconut. As many as four Neotropical whiteflies could be documented on coconut in a period of four years since 2016 after the advent of rugose spiralling whitefly (*A. rugioperculatus*). Morphological and evolutionary lineage of the non-native whiteflies infesting coconut is also briefed. Pesticide holiday and conservation biological control and bio-scavenging proved efficacious in the bio-suppression of invasive whiteflies on coconut. Emergence of exotic pests along airports, seaports (A. guerreronis) and roadways (*A. rugioperculatus*) is indicated. The potential invasive alien species at the country's doorstep viz., coconut leaf beetle, (*Brontispa longissima Gestro Coleoptera: Chrysomelidae*), armoured scale, (*Aspidiotus rigidus Reyne Hemiptera: Diaspididae*) and the coconut flat moth (*Agonoxena argaula Meyr. Lepidoptera: Agonoxenidae*) is also outlined with their ecological impact across neighbouring countries. Incursion management strategies include emergency preparedness module, systematic surveillance and empowering stakeholders through awareness campaigns to evade social and economic impact. Strengthening international and domestic quarantine and curbing illegal imports of planting materials including ornamental palms is the need of hour to evade bio-security risks associated with palms.

Introduction

Alien Invasive Species (AIS) is a non-native exotic pest which becomes established in natural or semi-natural ecosystems or habitat, and threatens native biological diversity and human livelihood worldwide. The spread of AIS is now recognized as one of the greatest threats to the ecological and economic well-being of any country. Invasions by alien species imbalance native ecosystems and are likely to breed profusely in the absence of natural enemies in the new environment and cause upsets in biodiversity by out-competing native species. Changes occurring in cropping patterns, adoption of modern agro-techniques, climate change and indiscriminate use of chemicals leading to diminishing defenders and pollinators add to the biotic imbalance and consequent emergence of new pest problems. Such outbreaks of quarantine pests viz., coffee berry borer *Hypothenemus hampei Ferrari, serpentine leaf miner Liriomyza trifolii* (Burgess), spiralling whitefly *Aleurodicus dispersus Russell*, coconut eriophyid mite *Aceria guerreronis Keifer, erythrina gall wasp, Quadrasticus erythrinae Kim*, the *eucalyptus gall wasp Leptocybe invasa Fisher & La Salle, cotton mealy*

a) Coconut eriophyid mite b) damage symptoms on young buttons c) damage on mature nut
d) Asian grey weevil e) damage symptom f) inflorescence moth

bug *Phenacoccus solenopsis (Tinsley), papaya mealy bug, Paracoccus marginatus Williams* and *Granara de Willink,* the rugose spiralling whitefly, *Aleurodicus rugioperculatus Martin*, nesting whiteflies (*Paraleyrodes bondari Peracchiand Paraleyrodes minei Iaccarino*) and *woolly whitefly, Aleurothrixus floccosus Maskell* reported in India caused severe economical loss to crops despite several efforts made to combat them.

Coconut which provides livelihood security to more than 10 million farm families and forms an integral component in food, fibre, shelter and medicine to mankind is no exception to such invasions. Among the 830 species of insects and mites reported worldwide infesting coconut, invasive and emerging pests have subdued its production significantly. The recent emergence of four invasive whiteflies on coconut viz., rugose spiralling whitefly (*Aleurodicus rugioperculatus*), nesting whiteflies (*Paraleyrodes bondari and Paraleyrodes minei*) and the palm whitefly (*Aleurotrachelus atratus*) and their aggressive invasive potential is a matter of great concern to the coconut sector.

The introduction of new pests into a locality is brought out in various ways such as through a host as the carrier, inert packing materials carrying the quiescent stages of the pest, insect vectors, birds, and air currents and deliberate, illegal introduction as bio-weapons. Though the first two modes of distribution are curtailed by quarantine measures, the latter two are beyond the limitations of pest control by exclusion. This creates a need for bio-security involving integrated approach that encompasses the policy and regulatory frameworks to analyze and manage the risks in the sectors of food safety and other environmental risks.

Bio-security covers the prevention as well as introduction of plant and animal pests and diseases, preventive-introduction of genetically modified organisms and their products and introduction and management of invasive alien species and genotypes. As such it is a holistic concept having direct relevance to the sustainability of agriculture, food safety and protection of the environment including biodiversity. It is in this context the likely advent of invasive insect pests like coconut leaf beetle (CLB), Brontispa longissima Gestro (*Chrysomelidae: Coleoptera*) and armoured scale insect, Aspidiotus rigidus Reyne (*Diaspididae: Hemiptera*) and the coconut flat moth (*Agonoxena argaula Meyr. (Lepidoptera: Agonoxenidae*) in India would be devastating and more likely an issue of bio-security in our country.

Incidence of Coconut Leaf Beetle (CLB) in Maldives and Union of Myanmar in 2007attacking

Whiteflies on coconut
A. dispersus a) Puparia b) colony; ***A. rugioperculatus*** c) puparia d) adults e) colony; ***P. bondari*** f) adult g) nest; ***P. minei*** h) puparia i) colony; ***A. atratus*** j) pseudopupa k) adult

the tender leaves of young coconut palms and its possible entry poses an imminent threat to coconut industry in India. The countries to the West of Myanmar, Bangladesh and India are at a very high level of risk, since the beetle cannot be stopped at land borders. For a country like India, where coconut and coconut-based industries support millions of people, the pest incursion would be catastrophic. Furthermore, bio-invasion of A. rigidus in Philippines has already infested approximately 7,80,000 trees affecting 50-70% of the coconut farms in Batangas and the nearby provinces. One of the key coconut insect pests on coconut in Fiji viz., the coconut flat moth, Agonoxena argaula Meyrick is another pest waiting at the borders. It is therefore considered a significant quarantine threat to any tropical country where coconut palms are grown. Keeping this in view, a surveillance survey was conducted to monitor the incidence of any invasive pests on coconut at all strategic entry points in the country and to devise effective strategies on incursion management in case of accidental introduction.

a) Coconut eriophyid mite: The exotic pest coconut eriophyid mite, Aceria guerreronis Keifer was reported from all coconut growing regions ranging from 0.2% in Bay Islands to 57.3% in Karnataka. Ever since the pest was first reported in the country from Kochi (Kerala) during 1998 it had spread to all coconut growing regions in key south Indian states. Notwithstanding the higher mite incidence during the initial years of emergence (1999-2000), the percentage incidence of mite diminished in subsequent years (2018-2019) with the population buildup of natural enemies especially the predatory mites (Neosiulus baraki) as well as the acaropathogen, Hirsutella thompsonii Fisher in the system. Strategies have now been evolved on the use of botanicals, palm oil-sulphur emulsion and palm health management techniques including soil-test based nutrition, biomass recycling and pest suppression through use of botanical preparations. Nation-wide sensitization and alert were exerted by all stakeholders and integrated approaches were used for the effective management of the pest. Of late, a selection made from a green tall genotype grown in Kulasekharam, Kanyakumari District (Tamil Nadu) and christened as Kalpa Haritha was released by ICAR-CPCRI as tolerant to mite attack. Evolving coconut varieties with round shape and tight perianth is the long-term strategy to subdue eriophyid mite.

b) Asian grey weevil: Myllocerus undatus Marshall, a pest of quarantine importance was registered from root (wilt) diseased tracts of coconut in Kerala in 2010. Mild to medium level of infestation damaging 5-10% leaf lamina of un-split leaves with typical notching-like symptom along the leaf margins was noticed on majority of the coconut seedlings in root (wilt) endemic zones. In the nursery area with nearly 10,000 coconut seedlings, more than 40% seedlings were found infested by the weevil. The characteristic feature of this weevil is the presence of three-spined hind femur and is considered as an invasive pest from Sri Lanka. Currently, this species is known as an invasive pest in Florida occurring on most of the South-Eastern and South-Western coasts and scattered inland regions infesting at least 81 different plant species including three ornamental palm species viz., Burmese fishtail palm, Caryota mitis Lour., Golden cane palm, Dypsis lutescens (H. Wendl.) Beentje & J. Dransf. and Veitchia palm, Veitchia sp. Very recently M. undatus is reported as a potentially destructive pest of citrus in Florida.

Coconut ash weevil, Myllocerus curvicornis Fab. was also noticed on coconut leaves of young palms especially on outer whorls in different tracts of Kerala.

c) Inflorescence moth: Occurrence of non-native inflorescence moth, Batrachedra arenosella (nuciferae)was observed from Port Blair-Bay Island, Minicoy-Lakshadweep Island, Kasaragod, Kayamkulam-Kerala, Ambajipeta-Andhra Pradesh, Jagdalpur-Chatisgarhh and parts of Karnataka during 1987. The pest is not assuming severe proportions in the main land probably due to the natural parasitism. The pest was quite severe in Niu Leka variety in Bay Island as well as dwarf genotypes in Lakshadweep Islands. Gummy exudates on unopened spathes are amply visible and male flowers turn necrotic. Rarely infestation is also observed on female buttons. Caterpillars are found to feed on the pollen grains of the male flowers. B. arenosella was reported as third important insect pest of coconut in Indonesia with active bio-suppression by parasitoids. In 1998, Batrachedra nucifera Hodges (Batrachedridae: Lepidoptera) was recorded from coconut in Venezuela.

d) Spiralling whitefly: Sporadic incidence of spiralling whitefly, Aleurodicus dispersus Russelrecorded from Minicoy, Kerala and Tamil Nadu during 1996was effectively bio-suppressed by natural enemies. As the name suggests, adults of A. dispersus has a typical spiralling fashion of egg-laying and found in mild to moderate levels during March-May. It is highly polyphagous pest infesting a wide array of crops in coconut plantations. Among the tall coconut genotypes, Benaulim was found to be highly susceptible. In Minicoy, the spiraling whitefly nymphs were reported more on papaya, banana, tapioca and castor and were found parasitized by the aphelinid parasitoids. Adults measure about 2 mm length with white wings. Direct feeding even under heavy infestations is usually insufficient to kill palms and no significant yield loss is being reported. Indirect damage is mainly accomplished by the accumulation of honeydew and white, waxy flocculent material produced by the adult whiteflies. In addition to the accidentally introduced aphelinids, viz., Encarsia guadeloupae Viggiani and Encarsia sp. nr. haitiensis Dozier, several natural enemies have expanded their host range to this invading pest in India. At least two different species of lady beetles Chilocorus subindicus Booth (Coccinellidae: Coleoptera) and Scymnomorphus sp. (Coccinellidae: Coleoptera) were found predatory on spiraling whitefly as well as on coconut scale insects. Conservation biological control using these lady beetles and aphelinid parasitoids is very important for the natural suppression of the spiralling whitefly infesting coconut.

e) Rugose spiralling whitefly: This exotic pest of Neotropical origin (Aleurodicus rugioperculatus) was reported from Kerala (Palakkad) and Tamil Nadu (Pollachi) simultaneously during 2016-2017.In a couple of years, it had invaded all coconut growing tracts of South India, North-East India including Assam, and Lakshadweep Islands (Kavaratti). The pest assumed significance on account of heavy dew excrements and subsequent encrustation by sooty mould (Leptoxyhium sp.). All life stages are confined on under surface of palm leaflets. Presence of rugose operculum and triangular lingula are the characteristic features of pest identification. More than 20 host plants are reported from the country of which coconut and oil palm are the most preferred hosts. Palms along the roadside, boundary of coconut garden and those exposed to higher solar insolation were found most suitable for pest establishment. ICAR-CPCRI has discovered a sooty mould scavenger beetle, Leiochirinus nilgirianus that could feed on sooty mould deposits during moist monsoon phase cleansing the palm leaflets and improving photosynthetic efficiency. More than 80% parasitism by the aphelinid parasitoid, Encarsia guadeloupae was recorded after 5-6 months after pest incursion. Management strategies include pesticide holiday, conservation biological control and bioscavenging using E. guadeloupae and L. nilgirianus respectively, installation of yellow sticky traps, spraying 0.5% neem oil and nutrition management to improve palm health.

f) Nesting whiteflies: Two non-native nesting whitefly species (Paraleyrodes bondari and Paraleyrodes minei) from Neotropical origin were reported from South India during 2018 on coconut either in isolation or co-occurring with rugose spiralling whitefly. These whiteflies are about 1 mm in size with P. bondari possessing distinct X-shaped marking on wings and P. minei is devoid of it. The male genitalia is cock-head shaped for P. minei and with typical dorsal and ventral horn-like structure for P.bondari. Nesting whiteflies and immature stages are restricted on the undersurface of palms leaflets. Adults rest on nest-like silver strands produced mainly by the immature stages. On account of their smaller size, the quantum of honey dew produced is low and also the subsequent sooty mould deposits. General lady beetles, Apertochrysa sp.and Cybocephalus

sp. were observed as potential predators. Though reported from citrus, guava was found to be a very common host for the nesting whiteflies. The invasive potential of rugose spiralling whitefly was reduced by its co-existence nesting whiteflies.

g) Palm whitefly: This is the latest exotic whitefly (Aleurotrachelus atratus) from Neotropical origin reported on coconut from Mandya and Mysuru, Karnatakaduring 2019. Due to its invasiveness and extensive host range, the species is considered as a pest of economic significance. A. atratus could cause economic damage as high as 55% on coconut in Comoro Island. It has oval puparium with dark cuticle, separated marginal tooth with round apex and serrated margin and tip-rounded lingula. Adults elongate with wings held roof-like on rest. Four predators were recorded but no parasitism was observed. It is a major pest on palm species and considered as a potential pest in the absence of parasitoids so far.

Impending biosecurity risks

Coconut leaf beetle, Brontispa longissima Gestro and the armoured scale insect, Aspidiotus rigidus ravaging Maldives and Philippines, respectively and the coconut flat moth, Agonoxena argaula restricted to Fiji Island though were not encountered in the survey, but are impending dangers at our door steps.

▶ *a) Brontispa longissima*

The outbreak of the B. longissima in Myanmar and Maldives in recent years poses a great threat and concern to the nearby countries such as India, Sri Lanka and Bangladesh. It is feared that the pest will find its way from Maldives to Sri Lanka and Southern parts of India to derail the economy of these important coconut growing regions of the world. Since invasive pests fail to get restricted along political / agro-ecological boundaries, countries like India, Bangladesh and Sri Lanka are ever in red alert zones. For all those countries, where coconut and coconut-based industries support millions of people, the pest incursion would be catastrophic. Adult beetles measure 7.5-10.0 mm long and 1.5-2.0 mm wide, with a conspicuous orange to reddish pronotum. The anterior part of elytra is also orange to reddish in colour. Grubs and adult beetles inhabit the developing unopened still folded heart leaves of coconut palm and feed on leaf tissues.

▶ *b) Aspidiotus rigidus*

Hard scale, A. rigidus, is a close relative of Aspidiotus destructor, a minor pest reported from Kerala, Tamil Nadu and other coconut growing tracts of the country. Gradient outbreak of coconut scale insect, Aspidiotus destructor was observed at Chingoli near Kayamkulam during August-September 2012. Though the pest attack was confined in a limited pocket on coconut leaflets along a homestead farm pond, rise in maximum temperature and reduction in relative humidity and rainfall during June-July 2012 could be the major reasons for the immediate flare up of the pest which was otherwise not reported as a major pest of the region. Population build up of the pest was so high that caused severe yellowing as well as drying of coconut leaflets in the region. This could be one of the earlier reports on temperature induced pest outbreak from Kerala, India. Comparison of maximum temperature, relative humidity and rainfall data of June 2011 with that of June 2012 revealed increase in 0.8^{o}C of maximum temperature and reduction in relative humidity and rainfall to the tune of 4.1% and 91.8 mm, respectively. Though A. destructor is under check by natural enemies, A. rigidus is ravaging Philippines incurring huge loss to coconut growers in that country. It is also reported as an emerging invasive threat in our country. The mobile stage being the crawlers and males are easily drifted away by wind or passively carried through any inert packaging materials, nuts etc.

▶ *c) Agonoxena argaula*

A. argaula is reported as a main pest on coconut in Pacific Island countries recorded mainly from Fiji, Samoa, Guam, Hawaii, Palmyra and Tongo. However, its occurrence is not reported from our country so far and remains as a potential invasive species. Besides coconut, it also attacks other palms viz., Metroxylon sp. and Clinostigma sp. Caterpillars feed on undersurface of coconut leaflets initially from middle aged leaves and extending to older ones giving a sick appearance to palms. During severe outbreaks,(conditions) as high as 40% leaf damage was observed causing 20% nut reduction. In young palms, growth is tremendously affected. Long thin window-like feeding damage is explicit on leaflets and larvae are confined on thin web covering the leaflets. In many cases, the symptoms are akin to that of leaf eating caterpillar damage prevalent in South India. Eggs are laid on undersurface of leaves along the midrib. Caterpillars are greenish and turn yellowish measuring 2 cm when matured. When disturbed, caterpillars are extra active moving backward and forward and sometimes dropping down. Adults are small moth measuring 5-9 mm long with prominent white stripe on males. The pest build up is normally

under check by the natural parasitism of stage-specific parasitoids viz., Apanteles sp., Bracon sp. and Brachymeriasp.

▶ *d) Red ring disease*

Red ring nematode, Bursaphelenchus cocophilus is a lethal nematode pest/pathogen of coconut which induces red ring disease. It is named after the typical brownish red circle or ring symptom, in the cross section of a diseased palm stem, which is derived from the defense responses of the host. After the infection of the nematode, the host palm shows external classical symptoms in one to two months, and eventually dies showing extensive wilt symptoms in a few months. The nematode is primarily vectored by the South American palm weevil, Rhynchophorus palmarum L. as an infective third stage juvenile. Presently the nematode and its vector insect are restricted in palm plantations of tropical and sub-tropical regions of America (West Indies and Latin America) and cause 15% loss of coconut and African oil palm annually

Incursion management of invasive pests

Three pronged strategies are essentially warranted to keep vigil on the introduction of invasive pest.

(ia) Strengthening quarantine:

Strict quarantine laws curbing the movement of all types of coconut materials and other host palms particularly ornamental palms from CLB infested countries should be enforced, as the main source of spread of this pest within the Asia-Pacific region is through shipment of ornamental palms from countries having the pest infestation. Shifting of soil and organic materials also should be passed through strict quarantine measures. In the collection of germplasm materials and exchange of genetic resources between countries rigorous quarantine steps are to be meticulously followed. Passengers traveling from beetle-infested countries should be encouraged to examine their baggage for the presence of the beetle / eggs / larvae to avoid accidental introduction of the pest. Trans-boundary movement of planting materials of palms especially ornamental palms between main lands and Islands as well between countries should be under strict vigil only after producing valid phytosanitary certificate (Rajan et al., 2012; Anonymous, 2015). The main mode of spread of invasive whiteflies is manly attributed to the distribution of infested coconut seedlings to the farmers. Quarantine officials need to be empowered on the invasive pests and hitherto should focus on biological searches rather than bullion snatches. Both aerial and marine trans shipment have to be covered under the umbrella of quarantine measures. Necessary phytosanitary certification by authorized agencies must be strictly enforced for the import of planting materials especially various palm species from pest affected countries. Domestic quarantine should be further strengthened to keep away from Wallacea jarawa reaching the mainland and also the invasive root knot nematode, Meloidogyne enterolobii not reaching pest-free states in the country. Airports and seaports of Kolkatta, Chennai, Vishakapatnam and Cuttack should be strictly monitored.

(i b) Domestic quarantine:

Restricted movement of planting material within the country from an infested area of invasive pests to a healthy pest-free one has to made under strict quarantine protocol. Prevention of movement of black headed caterpillar infested fronds from Kerala to Karnataka restricted the establishment of the pest in Karnataka region even during early 1920s. Coconut seedlings that are transported across the states should be free from the exotic whiteflies so that it is never a matter of concern in the new zone for which domestic quarantine is mandatory. Occurrence of Wallacea jarawa in Bay Islands especially in nurseries with older seedlings was observed. Hence the movement of seedlings/seed nuts from that region should be under strict domestic quarantine. Furthermore, fruit saplings should be free from the invasive M. enterolobii when transported from one region to another. Under domestic quarantine, wide spread establishment of exotic pests like wildfire can be restricted within the localized zone of emergence for which sustained efforts from quarantine is the need of the hour.

(ii) Surveillance and monitoring

Regular surveillance surveys should be carried out by all ICAR institutes, SAU and other stakeholders such as Coconut Development Board (CDB) at all strategic points of entry. More closely North-East regions, Lakshadweep and Bay Islands should be under strict surveillance by constant observation on buffer crops in those regions along the airport and seaport zones. With increasing navigation network these days such surveillance surveys on regular mode should be made mandatory. A national level incursion management team comprising of experts from all disciplines as well as an emergency preparedness module would be the need of the hour

to tackle accidental introduction of invasive pests including gradient as well as epidemic outbreaks of emerging pests in to the country. Concerted efforts for conservation of different natural enemies in the ecosystem are warranted for preventing emerging pests attaining epidemic levels. Conservation biological control and bio-scavenging using E. guadeloupae andL. nilgirianus was found successful in the bio-suppression of rugose spiraling whitefly.

(iii) Sensitization campaign

There is a need for educating the coconut growers and developmental workers about the pest and its bio-ecology so that they will be able to monitor the pest effectively in their areas of operation. Organizing seminars, awareness programmes, pest alert notifications, presentation of bulletins on B. longissima and A. rigidus are also would be helpful in building up an awareness and vigilance on the pest. Awareness creation and capacity building through training programmes is essential to contain the problem at this point of time. It was also suggested to display big posters at the lounges in airports and sea ports about the invasive pest and the damage symptom for the awareness of the travelers. Clippings can also be made about the invasive pests in Doordarshan news channel. ICAR-CPCRI has been in the vigil since 2007 and in case if any report on the incidence of invasive pests is located anywhere in the country, the matter can be brought to the attention of us (Anonymous, 2015). Even the sensitization campaign conducted by ICAR-CPCRI with the advent of invasive whiteflies on coconut was well appreciated from all quarters.

Finally, a planned and holistic programme through awareness creation, capacity building on incursion management and strict quarantine are essentially warranted to combat invasions due to such biosecurity threats. Creation of an incursion management team comprising of experts from all disciplines as well as an emergency preparedness module would be the need of the hour to tackle accidental introduction of invasive pests in to the country. A National Biosecurity System with a separate Ministry under Govt. of India is an immediate necessity to take forward issues on biosecurity literacy. ■

Abiu, an ideal intercrop in coconut garden

Nithin Alex, Jr. Scientist,
Homegrown Biotech, Vizhakathod, Kanjirapally, Kottayam

When considering an ideal inter or multi-tier crop system for coconuts; certain parameters need to be met which includes under storey nature of the proposed inter crop, shade tolerance, absence of collateral pest and diseases and allelopathic issue with their roots system. Status of coconut in such intercropping would always remain as the upper-storey plant and such intercrop suggested should perform well in the under-storey conditions. Intercrops should be able to establish and fruit well responding to the positives stresses without affecting the performances of coconut.

Abiu (*Pouteria caimito*), a fruit originated from the Amazonian rain forest gained good acceptance in the Australian market which led to the commercial cultivation of these fruits. Subsequently commercial varieties of Abiu were developed as Z series of which Z_2 and Z_4 were considered top-notch varieties. Abiu seedlings can start fruiting from their second year onwards and can give sizeable yields from 5th year and above. Abiu performs well in shaded and open conditions and thus this plant can be an ideal intercrop in coconut. The canopy of these can be maintained under 20 ft height and 15 ft of spread.

Ideal orchard conditions

In the case of new planting of coconut, spacing for coconut should be increased from the conventional spacing to allow accessibility for both plants. When considering intercrop, issues of fronds and nut falling can damage the under-storey plants and thus the coconuts should have 35ft of space between their rows. Abiu can be grown between these rows of coconut and spacing between each abiu in line should be 16ft and for coconuts in line can be 24ft. In this manner an acre of land can hold 50 numbers of coconut palms and 75 Abiu plants.

Advantages of Abiu

Summer fruit: Major season in Abiu is during the summer months unlike other major tropical fruits which enhances the marketing potential of this fruit. The fruit weighs 200 grams to 600 grams with excellent visual appeal. Abiu starts yielding from 2^{nd} year onward; the seedling is unique as it start to flower and fruit from the 2^{n}d year of planting.

Climacteric fruit: Abiu fruits can be harvested before ripening enabling economical logistics and enhanced keeping quality and could be stored at 20^{0}C for 2 weeks. Abiu is an excellent summer fruit which has two seasons, the major season being from January to February and minor season spreads from April to May.

Management protocols and necessary practices in Abiu:

Fruit wrapping to prevent pest attack- The plant need to be wrapped to protect the fruits from pest attack (esp. sucking pests) to conserve its visual appeal

Irrigation during hot months- Since abiu plants give their yield in summer, adequate watering is necessary to elevate the stress and increases fruit set and the overall size.

World Coconut Day' Celebration and Distribution of Awards of Coconut Development Board on 2nd September 2022

All coconut growing countries in the Asia and Pacific region observe 2nd September, the foundation day of the International Coconut Community (ICC), an intergovernmental organization, as World Coconut Day, every year. The objective of observing coconut day is to create increased awareness and importance of coconut and help focus national and international attention to this crop. The theme announced by ICC for World Coconut Day 2022 is "Growing Coconut for a Better Future and Life".

In India, every year World Coconut Day is celebrated under the aegis of Coconut Development Board. Shri. Narendra Singh Tomar, Ho'ble Union Agriculture Minister is expected to inaugurate this year's world coconut day celebration at Junagadh, Gujarat. The Minister will also inaugurate the State Centre of the Board at Junagadh, Gujarat and will declare the National Awardees and Export Excellence Awardees of the Board.

This year, World Coconut Day celebration also coincides with the International Workshop on Good Agricultural Practices, proposed to be organized jointly by Government of India and International Coconut Committee during 2-4 September 2022, at Hotel Le Meridien. Kochi, Kerala. The National Awards and the Export Excellence Awards instituted by the Board will also be distributed during the occasion.

Shri. Kailash Choudhary, Hon'ble Union Minister of State for Agriculture and Farmers Welfare is expected to attend the programme at Kochi and to distribute the awards on 2nd September 2022.

Around 600 coconut farmers and officials will attend the programme in Junagadh and 500 coconut farmers from across the country and senior officials from the Department of Agriculture/ Horticulture and Agricultural Universities from all coconut growing states are being invited to attend the World Coconut day Celebrations at Kochi. The International Workshop will have the presence of experts from over seven major coconut growing countries.

Regular weed management- Weeds are to be managed regularly especially during fruiting season to control pests that target the fruits

As the soil need to be conditioned during heavy rain fall seasons to support optimum growing conditions, dolomite or lime need to be applied during rainy seasons.

Nutrition management on periodic basis-

NPK application need to be carried out once in a year after harvest.

Potassium may be applied during flowering and fruiting season (applied twice in year; once during flowering and after fruit set)

Micronutrients is to be applied twice a year; 1st application after 2 weeks of NPK application and 2nd application during flowering season. Cattle manure or compost also need to be applied after harvest once in every year.

Tree training and pruning-

Plants need to be top worked at 4 feet after achieving a height of 6 feet. This will allow side shoots to develop and branch out properly. Removal of water shoots needs to be carried out regularly to ensure good growth, air-circulation and proper light reception. During fruiting season, branches need to be supported to prevent limb-breakage. ■

CDB stall awarded Best of India. Biz Award in Agro + Food & Beverage Pro 2022

Coconut Development Board, Regional Office, Bengaluru participated in the 19th Agro + Food & Beverage Pro 2022 held from 4th to 6th August 2022 at Dr. SP Mukherjee AC Stadium, Panaji, Goa organized by M/s. Trinity Ventures, Mumbai. The Board was awarded "Best of India. Biz Award" for its special display and presentation in the conclave.

The 19th edition of the event was inaugurated by Shri. Shripad Yesso Naik, Hon'ble Union Minister of State for Tourism, Ports, Shipping & Waterways. Dr. Pramod Sawant, Hon'ble Chief Minister, Government of Goa and other dignitaries including Shri. Nilesh Cabral, Hon'ble Minister for Public Works Department, Law and Judiciary, Environment and Legislative Affairs, Government of Goa were present during the occasion.

Dr. Pramod Sawant, Hon'ble Chief Minister, Government of Goa and Shri. Nilesh Cabral, Hon'ble Minister for Public Works Department, Law and Judiciary, Environment and Legislative Affairs, Government of Goa visited CDB stall and enquired about various coconut products. Board displayed various value added coconut products like Nata-de-coco, Coconut milk, Coconut milk powder, Virgin Coconut Oil and Coconut chips from various manufacturing units which are assisted under TMoC scheme and also displayed handicrafts made from coconut shell, coir and trunk. The stall was affixed with well informative posters displaying CDB schemes viz., TMoC, CDB- Market promotion, CIT training programmes etc. Booklets on CDB schemes, coconut products, cultivation technologies, neera and publications of the Board were distributed in CDB stall. The virgin coconut oil manufacturer - M/s. Old Goa Oils and Foods Pvt. Ltd, Goa displayed their products in the Board's stall. Coir Board, Spices Board, APEDA, KAPPEC, IARI New Delhi, Skill India, Tourism Department of various States and private companies exhibited their products and technologies in the expo.

Flag hoisting ceremony at CDB Head Quarter Kochi premises as part of Independance Day 2022.

ICAR Workshop on Strengthening of FPOs

Inauguration of FPO workshop by Sri G. Gopakumaran Nair, CGM, NABARD

A mentoring workshop for Strengthening FPOs sponsored by NABARD was convened by ICAR-CPCRI, Regional Station, Kayamkulam on 12th August 2022. Shri G. Gopakumaran Nair, Chief General Manager, NABARD inaugurated the workshop and spoke about the role of NABARD in delivering financial and technological support to all FPOs for moulding their sustainability to face up the brewing challenges. Shri G. Gopakumaran Nair, CGM, NABARD launched the rotary pressed coconut oil branded as "Grow Me Green'" developed by Odanadu Farmer Producers Company, Pathiyoor. Sri. S. Premkumar, General Manager, Canara Bank and Convener, SLBC inaugurated the FPO exhibition and highlighted the role of banking institutions lending credit facilities for better functioning and sustained cash flow of the FPOs. The technical session was moderated by Dr. Jiju P. Alex, Member, Kerala State Planning Board and Dr. C. Thamban, Principal Scientist, ICAR-CPCRI, Kasaragod and six expert speakers shared their experiences.

In the afternoon session, a panel discussion was convened. Dr. C. Thamban, Principal Scientist, S. Jayasekhar, Senior Scientist, ICAR-CPCRI, Kasaragod, P. Anithakumari, Head, ICAR-CPCRI, RS, Kayamkulam, A. Suresh, Asha Latha, Principal Scientists, ICAR-CIFT, Kochi, P. Muralidharan, Head, ICAR-KVK, Alappuzha and Shri. Reji Varghese, DDM (Kottayam), NABARD interacted with delegates and clarified their queries. During the panel discussion, Dr. A. Abdul Haris, Principal Scientist exposed two customized fertilizers (Kalpa Poshak and Kalpa Vardhini) developed by ICAR-CPCRI for the coconut farmers.

Dr. S.P. Jyothi, Managing Director, Ayyampalayam Farmers Producers Company Ltd., Dindigul, Dr. Remany Gopalakrishnan, CEO, Onnatukkara Coconut Producers Company, Kattanam, Shri. Vijayan, CEO, Paddy Producers Company, Pudukkad and Shri.

A view of exhibition stall and interaction with visitors

Jayakumaran, CEO, Edakkadu Farmers Producers Company shared their experiences and risk bearing abilities to sustain FPO.

Agri Start-ups represented by Shri. Jijo Paul, Resnova Technologies Pvt. Ltd, Kochi, and Shri. Devan Chandrasekhar, Fuselage Innovations, Kochi introduced their products/services viz., QR code imprinted seedling tagging, sensor for red palm weevil detection and drone application in farming, respectively which aroused good feedback

Earlier, Dr. Anitha Karun, Director, ICAR-CPCRI, Kasaragod outlined the technology support extended by ICAR-CPCRI to FPOs and effective linkage shared. More than 12 exhibits were displayed by FPOs and Agri Start-ups. Best Exhibition stalls were awarded with a certificate of appreciation. More than 350 farmers representing about 75 FPOs from across Kerala state and Tamil Nadu participated.

Inauguration of FPO exhibition and interaction with Agri Start-ups

Dr. P. Anithakumari, Head, ICAR-CPCRI, Regional Station, Kayamkulam welcomed the gathering and Dr A. Joseph Rajkumar, Principal Scientist proposed vote of thanks.

CPCRI Kayamkulam and India Post released Special Postal Cover and My stamp

On the eve of Bharat Ki Azadi Ka Amrit Mahotsav and as part of Kalpa Vajra platinum jubilee celebration, ICAR-CPCRI, RS, Kayamkulam commemorated 75 years of service to coconut community on 12th August 2022 by releasing a Special Postal Cover and 'My stamp' through India Post. Shri P. Prasad, Hon'ble Minister for Agriculture, Government of Kerala inaugurated the ceremony and highlighted the significant role of ICAR-CPCRI, RS, Kayamkulam towards coconut research and development and fostering the welfare of coconut farmers all over the country.

The meeting chaired by Adv U. Prathibha, Hon'ble MLA, Kayamkulam, Smt. Sheuli Burman, IPoS, Chief Post Master General, Kerala Circle released the Special Postal Cover of ICAR-CPCRI, Regional Station, Kayamkulam-on completion of 75 years of service to coconut community and 'My Stamp' depicting Kalpa Sankara- first ever coconut hybrid released for root (wilt) disease tract and handed it over to Hon'ble Minister for Agriculture. Dr. Anitha Karun Director, ICAR-CPCRI, Kasaragod outlined the technology generated for coconut farmers by the institute. Dr. P. Anithakumari, Head, ICAR-CPCRI, Regional Station, Kayamkulam welcomed the gathering and oriented the research outcome of the Institute. Smt. P Sasikala, Chairperson, Kayamkulam Municipality, Shri Shani Kurumpolil, President, Krishnapuram Grama

Smt. Sheuli Burman, IPoS, Chief Post Master General, Kerala Circle released the My stamp and handed over to Shri P. Prasad, Hon'ble Minister for Agriculture, Kerala

Panchayat Smt. Binu Ashok, Councillor, Kayamkulam Municipality offered felicitations. Dr. Regi Jacob Thomas, Principal Scientist proposed the vote of thanks. A philately exhibition showcasing stamps on coconut, Geographical Indication (GI) tagged crops, biodiversity, luminaries in different fields etc was also organized on the occasion attended by more than 1000 students. About 350 farmers representing 75 FPOs from across Kerala and parts of Tamil Nadu participated.

Cultivation Practices in Coconut Garden - September

Planting

In low lying areas, planting of coconut seedlings can be undertaken in small sized pits or on mounts raised to one metre above water table. Prevent accumulation of rain water in the seedling pits by ensuring adequate drainage. In regions like Tamil Nadu field preparation should be done for new planting.

Manuring

Circular basins of 1.8m in radius and 25 cm depth may be dug and green leaf or compost or farm yard manure at the rate 50 kg per palm may be spread in the basin. Two third of the recommended dose of chemical fertilizers may be spread over the green leaf or compost and covered. Application of 500 g N, 320 g P2O5 and 1200 g K2O per palm per year is generally recommended for adult plantations. To supply two-third of the above nutrients it is necessary to apply about 0.72 kg urea, 1 kg rock phosphate (in acidic soil) or 1.33 kg Super Phosphate (in other soils) and 1.33 kg of Muriate of potash (MOP). Under irrigated conditions, one fourth of the recommended dose of chemical fertilizers can be applied during September.

It is always recommended to apply chemical fertilizers based on the soil test results rather than going by the general recommendations.

Wherever Boron deficiency is noticed 100 g Borax may be applied in the basin. For coconut palms showing yellowing of leaves due to Magnesium deficiency, 0.5 kg of magnesium sulphate can be applied in the basins along with other fertilizers.

The above schedule of manuring is suitable for all the major coconut growing regions which are mostly benefitted by South-West monsoon during the season. In localities of Tamil Nadu, which are mostly benefitted by North- East monsoon the first dose (one third of recommended dose) of chemical fertilizers can be given during September. Under such situations, lime or dolomite or gypsum @ 1kg/ palm need to be applied two weeks before the first dose of chemical fertilizers are applied.

Green manuring

Wherever green manure crops are grown, plough in the green manure crop (after attaining 50 per cent flowering) and incorporate into the soil.

Intercultural operations

Ploughing/digging of interspace is to be undertaken to keep the plantation free of weeds. Care should be taken to avoid injury to coconut palm while ploughing.

Nursery management

Weeding should be done in the nursery. Five month old ungerminated nuts and dead sprouts should be removed from the nursery. In localities of Tamil Nadu, which are mostly benefitted by North-East monsoon, land preparation can be taken up for sowing seednuts.

Crown cleaning

Wherever crown cleaning has not undertaken during August the same may be done during this month.

Mulching

Mulching of palm basins can be undertaken during the second fortnight of September to conserve moisture

Plant protection

▶ *Integrated Pest Management*

▶ *Rhinoceros beetle*

Adopt mechanical method of control by extracting beetles with beetle hooks, without causing further injury to the growing point of the palm. The top most leaf axils may be filled with powdered neem cake/ marotti cake (*Hydrocarpus sp/ pongamia*) @ 250 g + fine sand (250g) per palm as a prophylactic measure. Fill the innermost three leaf axils with 4 g each of naphthalene balls covered with sand (12 g/palm) for juvenile palms. Placement of two perforated sachets containing *chlorantraniliprole a.i.* 0.4% (5 g) or fipronil (3 g) or one botanical cake (2 g) developed by ICAR-CPCRI and incorporation of the biomass of weed plant *Clerodendron infortunatum Linn.* in the cow dung/compost pit can also be done. The breeding sites may be treated with green muscardine fungus (*Metarhizium anisopliae*)

▶ *Red Palm Weevil*

Avoid causing injury to the palms, as they would attract the weevil to lay eggs. Mechanical injury if any, caused should be treated with coal tar. While cutting fronds, petiole to a length of 120 cm is to be left on the trunk to prevent the entry of weevils into the trunk. Removal and burning of palm at advanced stage of infestation would aid in destruction of various stages of the pest harboured in the trunk. Prophylactic leaf axil filling suggested for rhinoceros beetle is very essential as this pest pave way for red palm weevil.

If damage occurs in the crown, the damaged tissue has to be removed and insecticide suspension, *imidacloprid* (0.02%) @1 ml/L of water may be poured in. In case of entry of weevil through the trunk, the hole in trunk may be plugged with cement/tar and the top most hole is made slanting with the aid of an auger and the insecticide solution is poured through this hole with funnel.

▶ *Eriophyid mite*

Spraying on the terminal five pollinated coconut bunches with neem oil garlic soap mixture @ 2 per cent concentration (neem oil 200 ml, soap 50 g and garlic 200 g mixed in 10 litres of water) or spraying neem formulations containing 1 per cent azadirachtin @ 4 ml per litre of water or spraying palm oil (200 ml) and sulphur (5g) emulsion in 800 ml of water and root feeding azadirachtin 10,000ppm @ 10 ml + 10 ml water is effective. Along with the recommended dose of manures and fertilizers, 5 kg neem cake should also be applied.

▶ *Coreid bug*

Spray neem oil-soap emulsion (0.5%) on the pollinated bunches. The emulsion can be prepared by adding 5 ml neem oil and 8 g bar soap in one litre water.

▶ *Rugose Spiralling Whitefly*

No chemical insecticide should be sprayed on leaves. Apply 1% starch solution on leaflets to flake out the sooty moulds.

In severe cases, spray neem oil 0.5% and no

insecticide is recommended. Install yellow sticky traps on the palm trunk to trap adult whiteflies. Encourage build up of parasitoids (*Encarsia guadeloupae*) and re-introduce parasitized pupae to emerging zones of whitefly outbreak.

In situ habitat conservation of the sooty mould scavenger beetle, Leiochrinus. nilgirianus

Integrated Disease Management

▶ *Bud rot*

Remove the infected tissues of the spindle completely. Two or three healthy leaves adjacent to the spindle may have to be removed, if necessary, for easy removal of all rotten portions and thorough cleaning. After removing the affected tissues apply 10% Bordeaux paste and cover the wound with a polythene sheet to prevent entry of rain water. The protective covering has to be retained till normal shoot emerges. Destroy the infected tissues removed by burning or deep burying in the soil. Spray 1% Bordeaux mixture to the surrounding palms

▶ *Stem bleeding*

Avoid burning of trashes near the tree trunk. Avoid injury to the tree trunk. The affected tissues should be completely removed using a chisel and smear the wound with 5% hexaconazole (5 ml in 100 ml of water) and drench the basins @ 25 lit. of 0.1% solution

Smearing paste of talc based formulation of *Trichoderma harzianum* on the bleeding patches on the stem can be done (The paste can be prepared by adding 50 g of Trichoderma formulation in 25 ml of water)

Soil application of *Trichoderma harzianum* enriched neem cake @ 5kg per palm and adopt recommended irrigation/ moisture conservation practices.

▶ *Leaf rot*

Remove rotten portion of the spindle leaf and 2-3 successive leaves and pour fungicide solution containing 2 ml hexaconazole 5 EC in 300 ml water/ palm or talc based formulation of *Pseudomonas fluorescens* or *Bacillus subtilis* @ 50 g in 500 ml water/palm into the well around the base of the spindle leaf

Undertake prophylactic measures to prevent rhinoceros beetle attack

▶ *Basal Stem Rot/Ganoderma wilt*

Remove dead palms, palms in advanced stages of the disease and destruct the bole and root bits of these palms. Isolation of diseased palms from healthy palms by digging isolation trenches of 2 feet depth and one feet width around the basin can also be done. Avoid flood irrigation or ploughing in infected gardens to prevent spread of the inoculum.

Addition of 50 kg of farmyard manure or green leaves per palm per year and application of Trichoderma harzianum enriched neem cake@ 5 kg per palm and irrigating the palm once in 4 days and mulching around the basin is also useful.

Raise banana as intercrop wherever irrigation is possible Root feeding of hexaconazole @ 2% (100 ml solution per palm) or soil drenching with 0.2% hexaconazole / 1 % Bordeaux mixture @ 40 litre solution per palm can also be done.

Field sanitation

Special care should be taken to remove the organic debris/fallen trees etc in the coconut gardens in Kerala state affected by the recent heavy rainfall/ flood situation. ■

Market Review – July 2022

Domestic Price

Coconut Oil

During the month of July 2022, the price of coconut oil opened at Rs. 14600 per quintal at Kochi, Alappuzha market and Rs. 14800 per quintal at Kozhikode market. The price closed with a net loss of Rs. 200 per quintal at Kochi and Alappuzha market.

During the month, the price of coconut oil at Kangayam market opened at Rs. 12333 per quintal and closed at Rs. 11867 per quintal with a net loss of Rs. 466 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.07.2022	14600	14600	14800	12333
09.07.2022	14400	14400	14800	12000
16.07.2022	14400	14400	14800	11933
23.07.2022	14400	14400	14800	12000
30.07.2022	14400	14400	14800	11867

Milling copra

During the month, the price of milling copra opened at Rs.8450 per quintal at Kochi and Rs.8400 per quintal at Alappuzha and Rs.8750 per quintal at Kozhikode market.

The prices of milling copra closed at Rs. 8450 per quintal at Kochi market, Rs. 8300 per quintal at Alappuzha market and Rs. 8900 per quintal at Kozhikode market with a net loss of Rs.100 at Alappuzha market and a net gain of Rs. 150 per quintal at Kozhikode markets.

During the month the price of milling copra at Kangayam market opened at Rs.8200 and closed at Rs. 7950 per quintal with a net loss of Rs. 250 per quintal.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.07.2022	8450	8400	8750	8200
09.07.2022	8350	8300	8700	8000
16.07.2022	8350	8300	8700	7950
23.07.2022	8450	8300	8900	8100
30.07.2022	8450	8300	8900	7950

Edible copra

During the month the price of Rajpur copra at Kozhikode market opened at Rs. 12000 per quintal and closed at Rs. 13600 per quintal with a net gain of Rs. 1600 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
01.07.2022	12000
09.07.2022	11600
16.07.2022	11700
23.07.2022	12800
30.07.2022	13600

Ball copra

The price of ball copra at Tiptur market opened at Rs. 14200 per quintal and closed at Rs.14500 per quintal with a net gain of Rs.300 per quintal.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal) (Sorce: Krishimarata vahini)	
01.07.2022	14200
09.07.2022	14000
16.07.2022	13900
23.07.2022	14500
30.07.2022	14500

*NR-Not reported

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs.11300 and closed at Rs. 11000 per quintal with a net loss of Rs. 300 per quintal.

Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal)	
01.07.2022	11300
09.07.2022	11300
16.07.2022	11500
23.07.2022	11500
30.07.2022	11000

Coconut

At Nedumangad market in Kerala, the price of coconut opened at Rs. 12000 per thousand nuts and closed at the same price during the month.

At Pollachi market in Tamilnadu, the price of coconut opened Rs. 22000 per ton and closed at the same price.

At Bangalore market in Karnataka, the price of coconut opened at Rs. 19000 per thousand nuts and closed at Rs.17000 per thousand nuts with a net loss of Rs.2000 per thousand nuts during the month.

At Mangalore market in Karnataka, the price of coconut opened Rs. 28000 per ton and closed at the same price during the month.

Weekly price of coconut at major markets				
	Nedumangad (Rs./1000 coconuts)#	Pollachi (Rs./MT) ##	Bangalore Grade-1 coconut,(Rs./ 1000 coconuts) ##	Mangalore Black coconut (1 tonne) ##
01.07.2022	12000	22000	19000	28000
09.07.2022	12000	22000	17000	28000
16.07.2022	12000	22000	17000	28000
23.07.2022	12000	22000	17000	28000
30.07.2022	12000	22000	17000	28000

International price

Coconut

The price of coconut quoted at different domestic markets in Philippines, Indonesia, Srilanka and India are given below.

Weekly price of dehusked coconut with water				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
02.07.2022	175	147	129	277
09.07.2022	158	134	128	277
16.07.2022	154	147	133	277
23.07.2022	153	140	166	277
30.07.2022	NR	140	NR	277
				*Pollachi market

Coconut Oil

International price and domestic price of coconut oil at different international/ domestic markets are given below.

Weekly price of coconut oil in major coconut oil producing countries					
	International Price(US$/MT)	Domestic Price(US$/MT)			
	Philippines/ Indonesia (CIF Europe)	Philippines	Indonesia	Sri lanka	India*
02.07.2022	1600	NR	NR	1682	1553
09.07.2022	1598	NR	NR	1674	1511
16.07.2022	1515	NR	NR	1703	1503
23.07.2022	1439	NR	NR	1835	1511
30.07.2022	NR	NR	NR	NR	1494
					*Kangayam

Copra

The price of copra quoted at different domestic markets in Philippines, Srilanka, Indonesia, and India are given below.

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India* * Kangayam
02.07.2022	875	748	820	1032
09.07.2022	797	699	803	1007
16.07.2022	773	670	803	1001
23.07.2022	768	662	942	1019
30.07.2022	NR	674	NR	1001
				* Kangayam

#(Source: Epaper,Kerala Kaumudi),
##(Source: Star market bulletin)

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